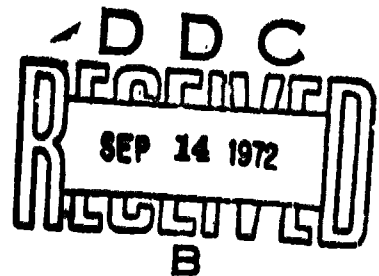


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**A NEW APPROACH TO CRITERION DEVELOPMENT IN THE  
REPLACEMENT AIR GROUP**

Richard H. Shannon, Wayne L. Waag, and John C. Ferguson



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**Bureau of Medicine and Surgery  
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## SUMMARY PAGE

### THE PROBLEM

A persistent problem in naval aviation has been the lack of adequate criteria for pilot performance in operational-type fleet aircraft. Any useful measure should include estimates of proficiency in basic flying skills as well as the unique skills dictated by the mission objectives for a particular aircraft. The replacement air group (RAG) seems to be the phase of training wherein these skills could be most easily isolated. The RAG is the postgraduate phase of training where the replacement pilot is first introduced to the operations of a fleet aircraft. Since the RAG is the final phase of preparation for fleet operations, it seems reasonable that the most important skills identified for this level of training should also be of importance in the estimation of fleet performance. The present investigation attempted to isolate the most critical skills and procedures within each of the stages comprising RAG training for the F-4 aircraft.

### FINDINGS

For each of the stages analyzed, a small set of skills and procedures were selected on the basis that they could adequately discriminate among replacement pilots categorized as "above average," "average," and "below average," according to their final overall RAG grade. Such items were also found to be highly predictive of the overall stage grade from which they were obtained. A multiple correlation coefficient (corrected for shrinkage) of .839 was obtained, predicting the final overall RAG grade when only five of the selected maneuvers were entered into the equation. These findings indicate that skills and procedures can be isolated which are highly predictive of performance in the RAG based on the final grade a student receives. It is suggested that such "critical" skills and procedures should form the basis from which an adequate measure of fleet performance can be developed.

## INTRODUCTION

At present the naval aviation training flight syllabus consists of four phases: primary, basic, advanced, and the replacement air group (RAG). The first three of these are considered the undergraduate level of training. Upon completion of the advanced phase, the student pilot is awarded his wings and is designated a naval aviator. The RAG is the postgraduate phase of training wherein the student is first introduced to the operations of a fleet-type aircraft. Upon completion of this phase, he is assigned to a fleet squadron.

To date, most of the past research effort has been devoted to the development of criteria for a reliable predication system based at the undergraduate level of training. Most often the pass/fail dichotomy or the final overall flight grade has been used. The success of such efforts within the laboratory is well documented. Nevertheless, the fact remains that a pilot is trained to become an integral part of an operational fleet squadron. Consequently, the best criterion of pilot performance must necessarily be the manner in which he fulfills the mission objectives of his particular aircraft. In developing performance measures, the replacement air group seems to be a fertile area for investigation because its activities are so similar to actual fleet operations. It is highly encouraging to note that several recent attempts have been made to extend the scope of research efforts into the RAG. Bale, Rickus, and Ambler (1) reported that certain grades during stages of undergraduate training were significantly related to RAG performance defined on a pass/fail dichotomy. Using a factor analytic procedure, Bale, Smith, and Ambler (2) reported substantial commonality among skills identified in both the undergraduate and postgraduate phases of training.

RAG training, like the undergraduate phases, is broken down into a series of stages. The number of stages and content of each are highly dependent upon the mission objectives for a particular aircraft. Within each stage, the replacement pilot is expected to demonstrate proficiency in the performance of a wide variety of skills and procedures. It is from the ratings which he receives on each of these items that his stage grades are determined. It seems reasonable that within each stage, certain of these skills and procedures should be of greater importance than others. It should be possible to isolate a small set of "critical" items that would discriminate among replacement pilots of differing ability levels. Such items, it is contended, should form the basis upon which an adequate fleet performance measure might be constructed. The purpose of the present investigation was to isolate the most important skills and procedures within each stage of the F-4 RAG in an attempt to identify those elements which would then form the basis of a fleet performance criterion for the F-4 aircraft.

## PROCEDURE

The sample group consisted of 52 first-tour replacement pilots assigned to VF-101, the east coast squadron for RAG training in the F-4 aircraft between December 1969 and June 1971. At that time the training syllabus for first-tour replacement pilots consisted of the following stages: Familiarization (PF), Instruments (PI), Weapons Systems (PS), Conventional Weapons (PW), Tactics (PT), and Field Mirror Landing Practice/Carrier Qualification (FMLP/CQ). A brief description of each of these stages is presented in the Appendix. Student flight records were obtained and item analyses performed for each of the above stages except PW. This stage was omitted due to the incompleteness of records.

With the final RAG grade as a criterion, the sample was divided into three approximately equal groups. In this manner, the sample replacement pilots were categorized as "above average," "average," or "below average." An attempt was then made to select items that would correctly categorize the sample into these classifications, based on their final overall grade.

The grading system for the east coast RAG requires the instructor to rate his students' performance on each skill and procedure as falling within one of four categories: Above Average (AA), Average (A), Below Average (BA), or Unsatisfactory (U). For each item within a stage, the number of AAs, BAs, and Us were recorded for each student across all hops. Items within a stage were selected for further analysis which could reasonably discriminate among the sample according to their categorization as "above average," "average," or "below average." An item was considered discriminating if the "above average" students received a relatively large number of AA ratings while the "below average" students received a relatively large number of BA and U ratings.

For each of the items selected in this manner, a difference score was obtained for each student, reflecting the distribution of AAs, BAs, and Us. For each student the number of AAs, BAs, and Us were summed across the entire stage for each item. These category sums were weighted by +1, -1, and -2, respectively, and then summed in order to yield an overall difference score. The resulting item difference scores were then standardized and transformed to T scores. These derived scores for each of the selected items were then related to the individual stage grade as well as the final RAG grade in a series of correlational and regression analyses.

## RESULTS

For the PF stage, 5 of 13 graded skills and procedures were selected. These included Headwork, Basic Airwork, Maneuvers, VFR Glide Slope Control, and Landings.

For the PI stage, none of the items was found to adequately discriminate among the three categories of replacement pilots. Three of 17 items were selected from the PS stage; these included Altitude Control, Headwork, and Basic Airwork. For the PT stage, 5 of 15 were selected, including Aggressiveness, Offensive Air Combat Maneuvering, Lookout Doctrine, Headwork, and Basic Airwork. Four of 13 items were selected from the FMLP/CQ stage; these included Speed Control, Glide Slope Control, Scan, and Power/Nose Control. Correlations were computed between the derived scores for each of these 17 items with the RAG grade for each stage as well as the final overall RAG grade. These results are summarized in Table I.

Table I  
Summary of Zero-Order Correlations Between  
Item Scores and RAG Grades

Item	Stage	Correlations With:	
		Stage Grade	Total Grade
Headwork	PF	.510	.035
Basic Airwork	PF	.699	.276
Landings	PF	.655	.194
VFR G/S Control	PF	.653	.244
Maneuvers	PF	.459	.108
Altitude Control	PS	.434	.302
Headwork	PS	.291	.121
Basic Airwork	PS	.255	.255
Aggressiveness	PT	.731	.447
Offensive ACM	PT	.867	.440
Lookout Doctrine	PT	.618	.265
Headwork	PT	.612	.217
Basic Airwork	PT	.639	.410
Speed Control	FMLP/CQ	.579	.611
Glide Slope Control	FMLP/CQ	.645	.549
Scan	FMLP/CQ	.534	.439
Power/Nose Control	FMLP/CQ	.695	.646

A series of regression analyses was then performed to determine the relative contribution of each of the items within a stage to the overall stage grade. By a forward selection regression procedure, multiple correlation coefficients (corrected for shrinkage) of .816, .435, .898, and .760 were obtained for the PF, PS, PT, and FMLP/CQ stages, respectively. All of the obtained  $R^2$ 's were highly significant.



A regression analysis was then performed in attempting to predict the final overall RAG grade from the 17 items selected. The obtained multiple R was .839, with only five items entered into the equation. These results are summarized in Table II.

Table II  
Summary of Multiple Correlation Analysis  
Predicting Total RAG Grade

Variable Selected	Stage of Training	Cumulative Shrunken R
Power/Nose Control	FMLP/CQ	.635
Offensive ACM	PT	.729
Scan	FMLP/CQ	.783
Basic Airwork	PS	.801
VFR G/S Control	PF	.839

## DISCUSSION

As the correlations from Table I indicate, the PT and FMLP/CQ stage items shared the most variance with the final overall RAG grade. This is not too surprising--at least from a rational viewpoint. These two stages are perhaps the most important for the F-4 community. Tactics defines the mission objectives of the fighter community, while proficiency in carrier landings is essential to get the pilot and aircraft safely off and onboard the ship. Further support for the importance of these stages is provided by the results of the regression analysis predicting the final overall RAG grade from the 17 items selected. Of the five items entered into the equation, those from the PT and FMLP/CQ stages accounted for 61 percent of the total variance of the criterion, while those from the PS and PF stages accounted for only an additional 9 percent. It is clear from these findings that any estimate of fleet performance must be heavily weighted by proficiency in Air Combat Maneuvering and Carrier Landings.

The procedures carried out in this investigation are most similar to an item analysis in test construction theory. In both instances the goal is to extract from the overall criterion that portion of the variance which can be reliably accounted for by scores derived from a small subset of the individual items. In this case the aim was to isolate the most important of the graded skills and procedures within each stage. As expected, only a few of the graded items were found to be highly relevant to the stage

grade a student receives. This reflects the fact that certain items simply do not discriminate among students. In most instances, this occurred whenever the vast majority of students received the same rating for a particular item.

The finding that five of the items accounted for 70 percent of the variance of the final RAG grade is certainly encouraging. It points to the feasibility of obtaining valid estimates of flight ability through the use of only a few item measures. The authors feel this to be of great importance in that brevity is one of the key requirements of any rating form to be completed by operational squadron personnel. It is hoped that by isolating the most important graded skills and procedures in the RAG, a valid measure of fleet performance can be constructed.

## REFERENCES

1. Bale, R. M., Rickus, G. M., and Ambler, R. K., Replacement air group performance as a criterion for naval aviation training. NAMRL-1126. Pensacola, Fla.: Naval Aerospace Medical Research Laboratory, 1970.
2. Bale, R. M., Smith, M. J., and Ambler, R. K., Factor analysis of undergraduate and postgraduate flight training grades. Aerospace Med., 43,372-375, 1972.

## **APPENDIX A**

### **SUMMARY OF F-4 REPLACEMENT PILOT FLIGHT SYLLABUS**

**FAMILIARIZATION (PF):** During the PF stage, the replacement pilot (RP) learns the basic requirements and procedures for operating the F-4 aircraft. These include pre-flight procedures, starting, taxiing, take-offs, and landings. He is also introduced to aircraft maneuvering, single engine performance, aerobatics, basic formation flight, and night operations.

**INSTRUMENTS (PI):** During the PI stage, the RP is introduced to instrument flight in the F-4 aircraft. He learns instrument take-offs, standard departures, penetrations, approaches, and landings. Upon completion of this stage, he is certified to be instrument qualified in the F-4.

**WEAPONS SYSTEMS (PS):** During the PS stage, the RP is introduced to the operations of the different missile systems in the F-4. Heavy emphasis is placed upon the development of skills in the basic intercept technique.

**CONVENTIONAL WEAPONS (PW):** During the PW stage, the RP is introduced to conventional air-to-ground weapons systems. He is also introduced to basic F-4 tactics, air refueling, and navigational procedures.

**TACTICS (PT):** During the PT stage, the RP is introduced to air combat maneuvering procedures in the F-4. He is introduced to those enemy weapons systems which he is likely to encounter and learns the best tactical procedures to defeat these systems.

**FIELD MIRROR LANDING PRACTICE/CARRIER QUALIFICATION (FMLP/CQ):** During this stage, the RP is prepared for carrier landings under both day and night operations.